World Ocean Database 2001 In A Nutshell: An informal guide

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(1) Introduction: This guide provides a brief overview of how to locate selected World Ocean Database 2001 (WOD01) data by instrument (or probe) type, decompress the data files, and read the data by means programs. Conkright et al. [2002] provide a detailed description of the WOD01.

(2) Understanding the WOD01 CD-ROM contents and directories: WOD01 comprises a total of eight CD-ROMs, seven contain the observed depth profile, surface, and plankton data (WOD01-01 through WOD01-07), and one contains all the standard depth level data (WOD01-08) as shown in Table 1. The CD-ROM contents are based on the different instrument types used to sample data [OSD, XBT, MBT, High Resolution Conductivity-Temperature-Depth (CTD), Bottle and Low Resolution CTD, Undulating Oceanographic Recorders, Floats, Buoys, Continuous measurements] as illustrated in Table 2. Each CD-ROM contains directories (in bold letters) with the following information: documentation files (**DOC**), description of metadata codes (**CODES**), utilities used to decompress the data (**UTILS**), sample FORTRAN and C programs for reading the data (**PROGRAMS**), the software program Ocean Data View for extracting and viewing the data (**ODV**), and a data directory (**DATA**).

(3) Locating data by WMO squares: The **DATA** directory contains data for the instruments listed in Table 2. Data for each instrument are located in a separate directory (Table 1). Within each instrument directory (Table 2), the data are organized by ten-degree latitude-longitude squares following the World Meteorological Organization (WMO) ten-degree square numbering scheme (Figures 1 and 2). Data in each WMO file are sorted by date. The data files in the **DATA** directory are named based on the WMO square where the data are located. The first 3 letters in each data file represent the instrument type (Table 2), the fourth letter represents whether the data are at standard (S) or observed (O) depths, and the last four numbers indicate the WMO square number where the data are located (Figures 1 and 2). Table 3 shows the standard levels and depths.

Example 1: Locate and extract Ocean Station Data (OSD) at observed depths with

geographic coordinates between the latitudes of 0° and 10°N and between the longitudes of 160°W and 170°W.

In Example 1, the region of interest is located in the North Pacific Basin in WMO square number 7016 as shown in Figure 2. Positive and negative longitudes in the WOD01 denote the Eastern and Western Hemispheres and positive and negative latitudes denote the Northern and Southern Hemispheres.

(4) Locating data by instrument type: Search the WOD01 CD-ROM directory by instrument type and by whether the data are on standard or observed depth levels (see Tables 1 and 2. In Example 1, the user requires profile data designated as instrument type OSD. All the OSD data at observed depths are located in CD-ROM number 1 (WOD01-01) and all the OSD data (as well as data for all other instruments) at standard depths are located in CD-ROM number 8 (WOD01-08) as shown in Table 1.

Since in Example 1 the user is looking for OSD data at observed depths located in the North Pacific Basin, search CD-ROM number 1 (WOD01-01) under the **/DATA/NPAC** directory for the data file *OSDO7016.gz*. Note that *OSDO7016.gz* is a gzip compressed data file (see below how to decompress data). The first 3 letters in *OSDO7016* represent the instrument type (OSD), the fourth letter represents whether the data are at standard (S) or observed (O) depths, and the last four numbers indicate the WMO square number (7016). The procedure for locating data files for any instrument type listed in Table 2 is similar.

(5) Decompressing data: For simplicity, copy the file *OSDO7016.gz* from the CD-ROM WOD01-01 to your working directory. The **UTILS/GZIP** directory contains files used for decompressing the data for DOS and UNIX users. It is assumed that the user has successfully installed *gzip*. To decompress *OSDO7016.gz* use the command: *gzip -nd OSDO7016.gz* (Refer to the **UTILS** directory or the gzip World Wide Web site at: http://www.gzip.org/)

(6) Reading the data using the sample programs provided: The **PROGRAMS** directory contains sample programs in FORTRAN and C for reading the WOD01 data.

This example uses *wodFOR.f* to illustrate how read the data file *OSDO7016*. The program *wodFOR.f* is a FORTRAN program designed as an example on how to read selected WOD01 data by WMO squares. This program can read data from any instrument at observed or standard depths. First, copy *wodFOR.f* to your working directory and then make (compile) an executable. It is assumed that the user is familiar with compiling FORTRAN programs (e.g., under Unix*: f77 -o <executable_file> <program_file.f>*). Suppose that the name of the executable is *wodFOR* (or any other name). To execute *wodFOR*, type: *wodFOR*. The program then requests the data file name as input - “Input File Name (in quotes)”. Enter the file name in single quotation marks: *'OSDO7016'*. The program displays to the screen the first ten stations in the

OSDO7016 data file. Table 4 shows the first station in *OSDO7016*.

Each instrument type has different variables. For example, OSD data include chemical, physical, and biological variables (Table 5). The sample output from *wodFOR.f* shows that OCL unique station number 159608 contains six variables (1=temperature, 2=salinity, 3=oxygen, 4=phosphate, 6=silicate, and 9=pH) as a function of depth (refer to Table 5 for codes). Each station includes variable-specific and secondary header codes denoting information about the station such as meteorological data, originator's methods and instruments, ship and cruise name, etc, when such information is available (Refer to the **CODES** directory for codes).

A note on other sample programs provided with the CD-ROMS: Any of the FORTRAN or C programs can read WOD01 data from any instrument type shown in Table 2. The FORTRAN program *wodASC.f* reads the WOD01 data from a user selected WMO square and outputs a user selected variable as a function of depth in either fixed tabular (columns) or comma separated columns. The C program *wodC.c* outputs data the same as *wodFOR.f*. Each of the programs include comments describing data arrays, subroutines, etc. The user can modify these programs according to specific needs.

(7) Reading the data using Ocean Data View: The **ODV** directory contains the Ocean Data View (ODV) version 5.6 for Microsoft Windows developed by Reinier Schlitzer [Schlitzer, 2002]. ODV will read (import) selected WOD01 data files in gzip compressed or decompressed format and offers options for displaying the data. Examples 2 and 3 below illustrate how to open a new collection and import single and multiple data files into ODV. It is assumed that the user has successfully installed ODV (*readODV.txt* in the top directory of each CD-ROM describes the installation steps; for additional information the user should refer to the ODV manual or the ODV World Wide Web site at http://www.awi-bremerhaven.de/GEO/ODV/)

Example 2: Open a new data collection and import a single WOD01 data file (*OSDO7016.gz*) into ODV.

Opening a new data collection: In the upper menu bar of ODV (Figure 3), click on (select) the *file* tab to open the file menu. Then click on *New* to create a new collection in a user's selected working directory (or the user can open any existing collection if one is available). ODV will then request a name for the new collection under *file name*. In Example 2, enter *OSDO* (or any other file name) under *file name* and then click *Open* to continue. ODV displays on the screen a banner indicating that this "collection does not exist!". Press *ok* to continue.

Defining collection variables: After opening the collection *OSDO*, ODV displays a menu of *Definitions of Collection Variables*. Click on the selection arrow to display the list of collection variable definitions and choose *World Ocean Database variables*. Click *ok* to

continue. ODV displays to the screen a menu identifying the default variables included in the World Ocean Database. Press *ok* to continue.

Importing a single data file into the collection: In the upper menu bar of ODV (Figure 3), click on the *Import* tab to open the import menu, then click on *World Ocean Database*, and finally click on *single file*. ODV then displays a browser menu called *Select World Ocean Database File*. Browse to the working directory where you have placed a copy of the file *OSDO7016.gz* (or *OSDO7016*). Click on this file to select it as *File name*. Press *Open* to continue. ODV then displays a *Selection Criteria* context menu. Press *ok* to continue. ODV then displays a *Import Options* menu. Press *ok* to continue. After importing data from *OSDO7016.gz* into the collection, ODV displays a banner indicating how many stations were imported. Note that once you have created a collection, you can import additional data files into the same collection. Figure 3 shows information contained in each OSD as displayed by ODV.

Example 3: Open a new collection and import several OSD data files into ODV

Opening a new data collection: In the upper menu bar of ODV (Figure 3), click on the *file* tab to open the file menu. Then, click on *New* to create a new data collection in a user's selected working directory (or the user can open any existing collection if one is available). ODV will then request a name for the new collection under *file name*. In our Example 3, enter *mydata* (or any other file name) under *file name* and then click *Open* to continue. ODV displays on the screen a banner indicating that this "collection does not exist!". Press *ok* to continue.

Defining collection variables: After opening the collection *mydata*, ODV displays a context menu of *Definitions of Collection Variables*. Click on the selection arrow to display the list of collection variable definitions and highlight (choose) *World Ocean Database variables*. Click *ok* to continue. ODV displays to the screen a menu identifying the default variables included in the World Ocean Database. Press *ok* to continue.

Importing multiple data files into the collection: Importing multiple data files into ODV requires a text (ASCII) file that contains a listing of the data file names that the user wishes to import into a new or an existing collection. The **DATA** directory has a text (ASCII) file listing all WMO data file names in that directory. For example, all the OSD data files at observed depths in the North Atlantic Basin are listed in the text file *OSDONATL.lst*. The user can create their own file listing the data file names according to specific needs. For Example 3, use any text editor to create a file called *myfile.lst* (or any other file name) in the working directory containing the following data file names (one file name per line):

OSDO7201.gz
OSDO7202.gz
OSDO7203.gz

Locate and copy these data files from the WOD01-01 **DATA/NATL** directory into the working directory that contains *myfile.lst*. Note that the list file *myfile.lst* can contain any number of data files (in any order).

In the upper menu bar of ODV (Figure 3), click on the *Import* tab, then click on *World Ocean Database*, and finally click on *multiple files*. ODV then displays a browser menu called *Select World Ocean Database File List*. Browse to the working directory and select the myfile.lst file. Click on *Open* to continue. ODV then displays a *Selection Criteria* context menu. Press *ok* to continue. ODV then displays a *Import Options* menu. Press *ok* to continue. After importing all the OSD data files listed in *myfile.lst* into the collection, ODV displays a banner indicating how many stations were imported. Note that once a collection has been created, additional single or multiple data files can be imported. Figure 3 shows information contained in each OSD as displayed by ODV.

ODV and OCL variable quality flags: ODV has four variable quality flags: Good, Unknown, Questionable, and Bad. These quality flags in ODV translate OCL variable quality flags as follows: ODV “Good” translates to OCL quality flag 0; ODV “Unknown” translates to OCL missing value; ODV “Questionable” translates to OCL flags 2-5 for entire profile or individual observations; and ODV “Bad” translates to OCL flags 6-9. Table 6 shows the OCL variable quality flags. Since ODV does not have a single entire profile quality flag, the OCL entire profile quality flags are assigned to each depth and variable (Refer to the **CODES**, **DOC**, and **ODV** directories for additional Information). The OCL quality controlled variables are: temperature, salinity, oxygen, phosphate, silicate, nitrate, nitrate+nitrite, pH, chlorophyll, alkalinity, pCO_2 and TCO_2.

(8) Reporting data problems, suggestions, comments about WOD01: If any errors are found in the WOD01, please contact the Ocean Climate Laboratory and the problems will be corrected. Comments or suggestions for improving WOD01 would be appreciated. Updates to the programs and changes to WOD01 will be posted in the NODC/OCL World Wide Web site at: http://www.nodc.noaa.gov/OC5

(9) References

Conkright M. E., J. I. Antonov, O. Baranova, T. P. Boyer, H. E. Garcia, R. Gelfeld, D. D. Johnson, R. A. Locarnini, P. P. Murphy, T. D. O'Brien, I. Smolyar, C. Stephens, *2002: World Ocean Database 2001*, Volume 1: Introduction. Ed: S. Levitus, NOAA Atlas, NESDIS 42, U.S. Government Printing Office, Washington, D.C., 167 pp.

Levitus, S., 1982, Climatological Atlas of the World Ocean, NOAA Professional Paper 13, U.S. Government Printing Office, Washington, D.C.

Schlitzer, R., 2002, Ocean Data View, http://www.awi-bremerhaven.de/GEO/ODV/

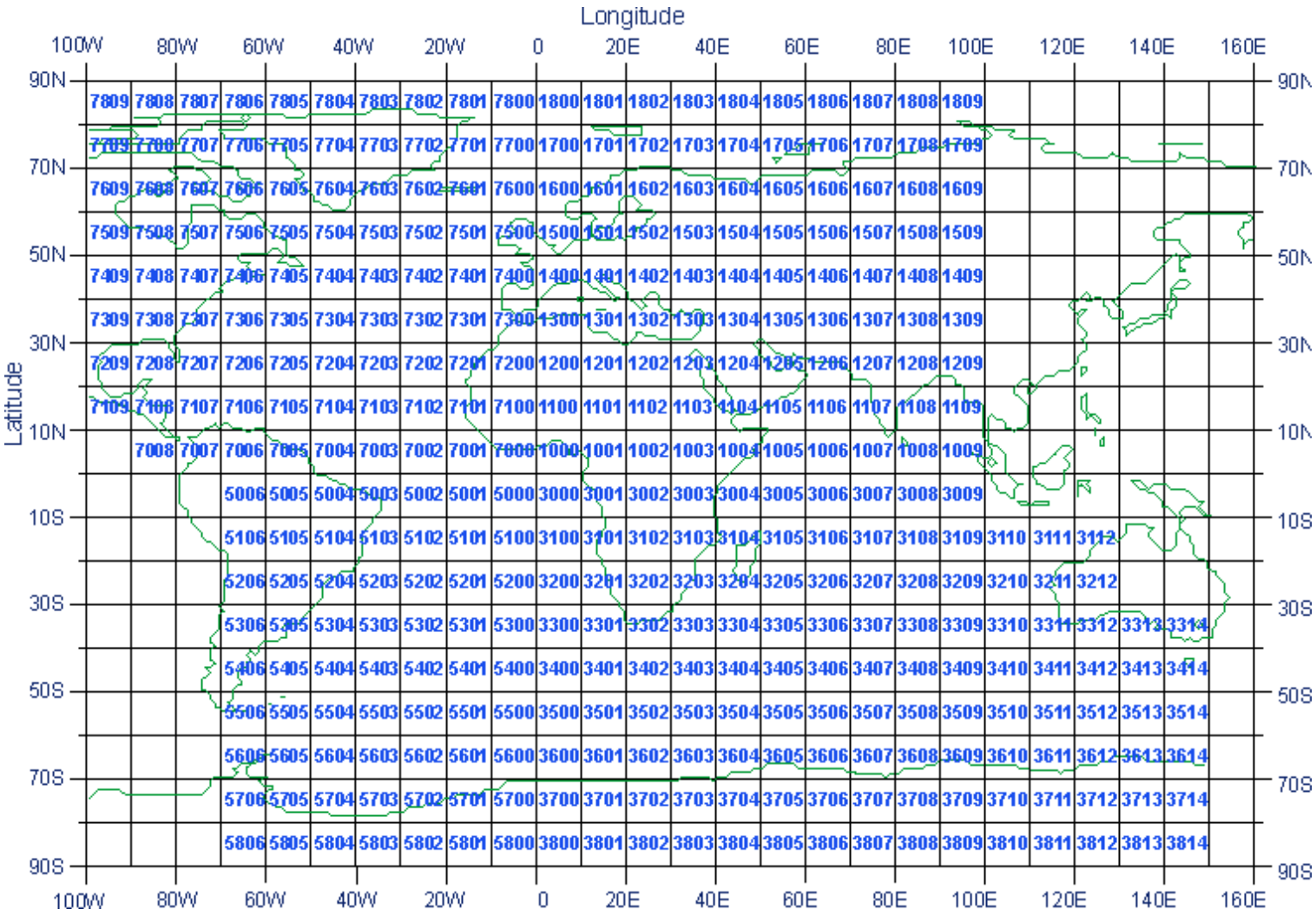

Figure 1. WMO squares in the Atlantic and Indian Basins (See Figure 2 for WMO squares in the Pacific Basin)

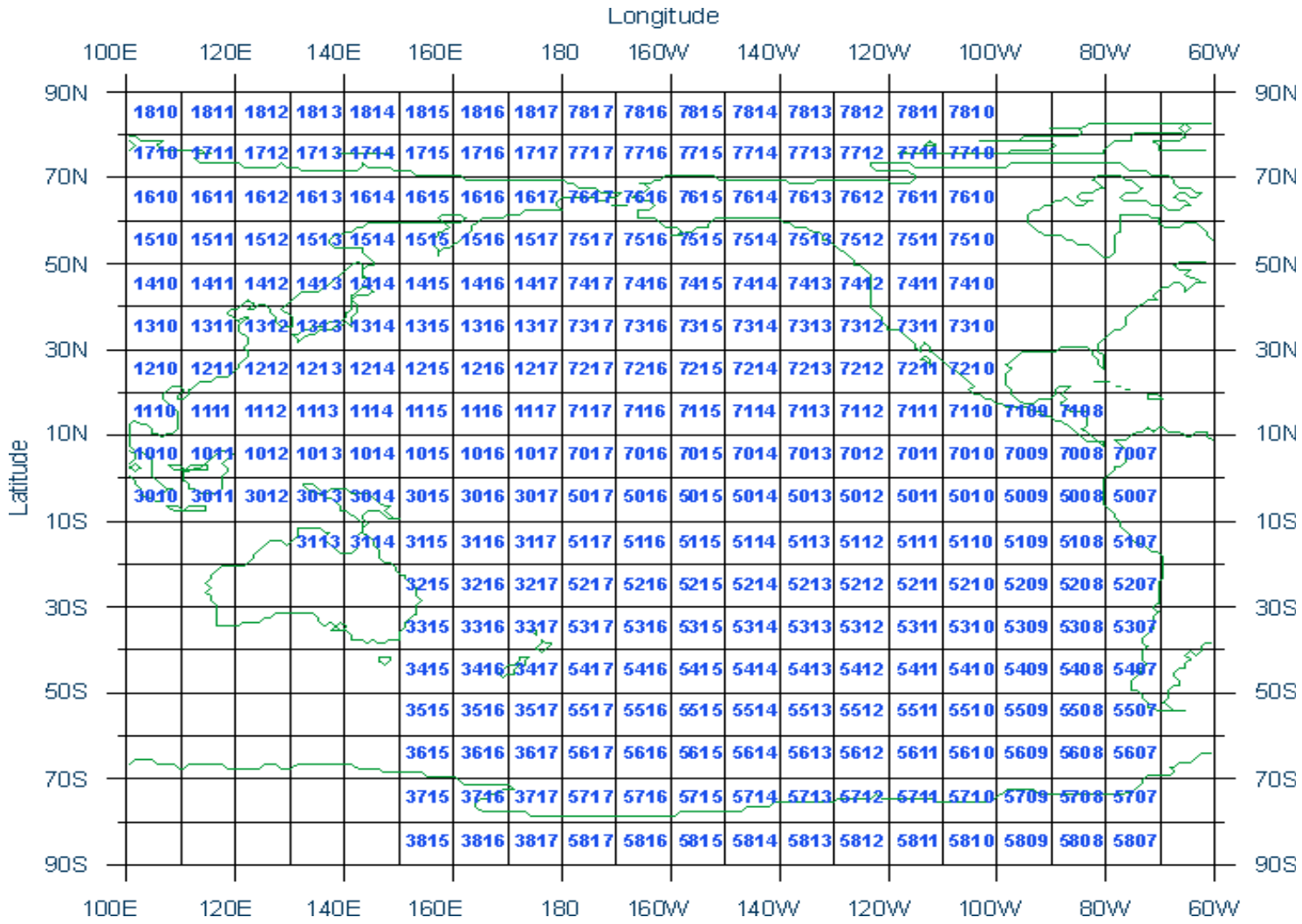

Figure 2. WMO squares in the Pacific Basin (See Figure 1 for WMO squares in the Atlantic and Indian Basins)

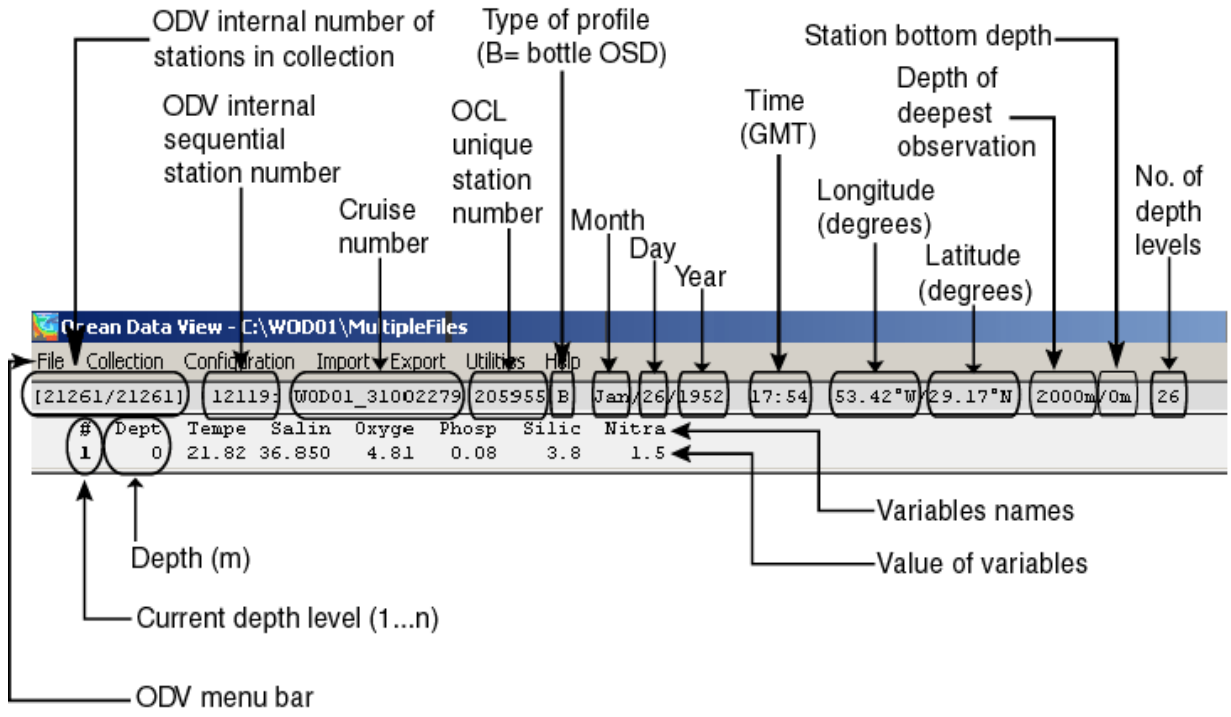

Figure 3. WOD01 station information and profile data as displayed on Ocean Data View (ODV). All the information corresponds to WOD01 unless otherwise specified as ODV internal information. Some station information such as for example profile bottom depth might not exist on all stations.

Table 1. Contents of the WOD01-01 through WOD01-08. See Table 2 for instrument types.

CD-ROM	CONTENT
WOD01-01	Bottle/Surface data for all ocean basins [North Atlantic (NATL), South Pacific (NPAC), Southern Hemisphere and Indian Basin (SHIND), and surface only data (SURF)]
WOD01-02	CTD/UOR data for the North Atlantic [0° to 90° N]
WOD01-03	CTD/UOR data for the North Pacific [0° to 90°N]
WOD01-04	CTD/UOR data for the Southern Hemisphere and Indian Ocean
WOD01-05	XBT/MBT/APB/MRB/PFL/DRB data for: North Atlantic [0° to 90° N]
WOD01-06	XBT/MBT/APB/MRB/PFL/DRB data for the North Pacific [0° to 90°N]
WOD01-07	XBT/MBT/APB/MRB/PFL/DRB data for the Southern Hemisphere and Indian Ocean
WOD01-08	Standard level data for all instruments for all ocean basins

Table 2. Instrument types in the WOD01. See Table 1 for WOD01 CD-ROM directories.

DIRECTORY	SOURCE
OSD	Ocean Station Data: Bottle, low resolution Conductivity-Temperature-Depth (CTD), and plankton data
CTD	High resolution CTD data
MBT	Mechanical Bathythermograph data
XBT	Expendable Bathythermograph data
SURF	Surface only data
APB	Autonomous Pinniped Bathythermograph
MRB	Moored buoy data
PFL	Profiling float data
DRB	Drifting buoy data
UOR	Undulating Oceanographic Recorder

Table 3. Standard levels and depths (meters).

Depth	Level	Depth	Level	Depth	Level	Depth	Level
0	1	250	11	1200	21	4500	31
10	2	300	12	1300	22	5000	32
20	3	400	13	1400	23	5500	33
30	4	500	14	1500	24	6000	34
50	5	600	15	1750	25	6500	35
75	6	700	16	2000	26	7000	36
100	7	800	17	2500	27	7500	37
125	8	900	18	3000	28	8000	38
150	9	1000	19	3500	29	8500	39
200	10	1100	20	4000	30	9000	40

Table 4. Sample data output (station 159608) from file OSDO7016 using *wodFOR.f.* The output shows six variables as a function of depth, quality flags, and secondary header codes [“f” and “o” values denote OCL and originator’s quality flags; numbers in parenthesis indicate the number of significant digits; “VarFlag” indicate whole profile quality flags; missing values are denoted as -999.99]. Refer to the text and to the **CODES** and **DOC** directories for additional Information.

```
-----------------------------------------------------------
Output from ASCII file,  profile#           1
-----------------------------------------------------------

CC  cruise Latitde Longitde YYYY MM DD    Time  Station #levels
77    1232   8.670 -169.470 1947 12 20   22.00   159608     13

Number of variables in this profile: 6

Originators Cruise Code: 77470418

    z  fo     1        fo     2        fo      3       fo      4       fo      6       fo      9       fo

   0.0 00   27.500 (4) 00   34.270 (4) 00    4.830 (3) 00    0.290 (2) 00    5.000 (1) 00    8.130 (3) 00
  24.0 00   27.510 (4) 00 -999.990 (0) 00 -999.990 (0) 00 -999.990 (0) 00 -999.990 (0) 00 -999.990 (0) 00
  48.0 00   27.490 (4) 00   34.350 (4) 00    4.810 (3) 00    0.260 (2) 00    6.000 (1) 00    8.140 (3) 00
  72.0 00   26.330 (4) 00   35.010 (4) 00    4.430 (3) 00    0.420 (2) 00    9.000 (1) 00    8.110 (3) 00
  96.0 00   21.160 (4) 00   34.880 (4) 00    3.810 (3) 00    0.650 (2) 00    9.000 (1) 00    8.050 (3) 00
 144.0 00   13.990 (4) 00   34.560 (4) 00    2.780 (3) 00    1.550 (3) 00   21.000 (2) 00    7.910 (3) 00
 194.0 00   11.100 (4) 00   34.650 (4) 00    0.750 (2) 00    2.520 (3) 00   32.000 (2) 00    7.730 (3) 00
 293.0 00    9.720 (3) 00   34.700 (4) 00    0.570 (2) 00    2.520 (3) 00   41.000 (2) 00    7.710 (3) 00
 392.0 00    8.960 (3) 00   34.660 (4) 00    0.540 (2) 00    2.810 (3) 00   49.000 (2) 00    7.660 (3) 00
 491.0 00    8.140 (3) 00   34.620 (4) 00    0.630 (2) 00    2.900 (3) 00   56.000 (2) 00    7.670 (3) 00
 587.0 00    6.310 (3) 00   34.560 (4) 00    0.450 (2) 00    3.120 (3) 00   68.000 (2) 00    7.640 (3) 00
 779.0 00    5.460 (3) 00   34.560 (4) 00    0.960 (2) 00    3.040 (3) 00   86.000 (2) 00    7.630 (3) 00
 971.0 00    4.590 (3) 00   34.580 (4) 00    1.470 (3) 00    3.060 (3) 00   98.000 (2) 00    7.710 (3) 00

VarFlag:               0              0               0               3               3               0

Secondary header #  1       126. (3)
Secondary header #  3      6185. (4)
Secondary header #  7       130. (3)
Secondary header # 10      5450. (4)
Secondary header # 18         3. (1)
Secondary header # 19         9. (1)
Secondary header # 21         4. (1)
```

Table 5. Variables in the Ocean Station Data files (OSD).

CODE	VARIABLE	UNIT/SCALE
1	Temperature (*in situ)*	EC
2	Salinity	PSS
3	Oxygen	ml l^{-1}
4	Phosphate	µM (µmol l^{-1})
6	Silicate	µM (µmol l^{-1})
8	Nitrate	µM (µmol l^{-1})
9	pH	no units
11	Chlorophyll	mg m^{-3}
17	Alkalinity	meq l^{-1}
20	pCO_2	µatm
21	TCO_2	mmol l^{-1}
23	NO_2+NO_3	µM (µmol l^{-1})
25	Pressure	decibar
also included in OSD are Plankton/Biomass data with various units.		

Table 6. Definition of the Ocean Climate Laboratory quality flags.

(1)	FLAGS FOR ENTIRE STATION (AS A FUNCTION OF VARIABLE)
0	accepted station
1	failed annual standard deviation check
2	two or more density inversions (Levitus, 1982 criteria)
3	flagged cruise
4	failed seasonal standard deviation check
5	failed monthly standard deviation check
6	flag 1 and flag 4
7	bullseye from standard level data or failed annual and monthly standard deviation check
8	failed seasonal and monthly standard deviation check
9	failed annual, seasonal and monthly standard deviation check
(2)	**FLAGS ON INDIVIDUAL OBSERVATIONS**
(a) Depth Flags	
0	accepted value
1	duplicates or inversions in recorded depth (same or less than previous depth)
2	density inversion
(b) Observed Level Flags	
0	accepted value
1	range outlier (outside of broad range check)
2	failed inversion check
3	failed gradient check
4	observed level “bullseye” flag and zero gradient check
5	combined gradient and inversion checks
6	failed range and inversion checks
7	failed range and gradient checks
8	failed range and questionable data checks
9	failed range and combined gradient and inversion checks
(c) Standard Level Flags	
0	accepted value

1	bullseye marker
2	density inversion
3	failed annual standard deviation check
4	failed seasonal standard deviation check
5	failed monthly standard deviation check
6	failed annual and seasonal standard deviation check
7	failed annual and monthly standard deviation check
8	failed seasonal and monthly standard deviation check
9	failed annual, seasonal and monthly standard deviation check
(d) Biological data flags (applied only to Comparable Biological Value - CBV Taxa code 27)	
0	accepted value
1	range outlier (outside of broad range check)
2	questionable value (“bullseye flag”)
3	group was not reviewed
4	failed annual standard deviation check

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